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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Ho et al.

Application No.: 09/743,621

Filed: April 9, 2001

For: OPTICAL DEVICES

Group Art Unit: 1714

Examiner: Edward J. Cain

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By: Judi Williams
Judi Williams

Commissioner for Patents
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RESPONSE TO EXAMINER'S ACTION

This is in response to the examiner's action mailed April 11, 2003, to which response is due July 11, 2003.

This is a first office action following Applicant's filing of an RCE on October 8, 2002, and submission under 37 C.F.R. § 1.114 (responsive to the final action mailed July 9, 2002) filed December 9, 2002. In this office action, the Examiner rejects claims 1-37 under 35 U.S.C. § 112 second paragraph, as being indefinite. The Examiner

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states that it is unclear whether claim 1 refers to a solution or dispersion of the nanoparticles and whether the other material is dissolved or not. The composition claims 24-34 and 37 also allegedly fail to particularly point out or distinctly claim the invention on the grounds that it is inconsistent to recite a solution of particles.

In response, Applicant first wishes to confirm the status of the present claims. Applicant believes the Examiner may have been referring to the original claims 1-37 in the published PCT application (WO 00/03950) on which this U.S. filing is based, rather than the claims as amended by a preliminary amendment filed January 12, 2001 (along with the U.S. application), and an amendment of claim 1 filed May 14, 2002. For example, the Examiner refers to claims 36 and 37, which were deleted by the preliminary amendment.

Thus, for clarity, Applicant attaches a copy of pending claims 1-35 as amended in the parent application.

Referring now to claim 1, a method is described in which a mixture of nanoparticles with another material are subjected to a step of washing the mixture with a solvent. The result is to form a solution of nanoparticles in the solvent, and to remove the other material. It is this language "a solution of nanoparticles in the solvent" to which the Examiner objects as unclear. More specifically the Examiner states:

> "It is unclear whether claim 1 refers to a solution or a dispersion of the nanoparticle[s] and whether the other material is dissolved or not."
>
> "Claim 24 is directed to a solution of nanoparticles. However, in solution the nanoparticles are no longer present as particles because they have been dissolved in the solvent to form the solution. It is inconsistent to recite a solution of particles."

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Applicant will show that based upon the specification it is clear what is meant in claims 1 and 24, namely that the nanoparticles are particles in "a solution of nanoparticles" as claimed.

On page 1 of the specification, Applicant describes nanoparticles in the field of colloid chemistry:

> "Nanoparticles are particles of very small size, typically less than 100 nm across. The preparation of well-defined nanoparticles via colloid chemistry was demonstrated at least as early as the 1980's" (page 1 second paragraph).

Then on pages 4-5, Applicant describes certain aspects of the invention in language similar to that set forth in the present claims. More specifically, Applicant refers to the washing step for forming "a solution of nanoparticles in the solvent" (page 4 last line to page 5 first line). This is the subject matter of claims 1 and 24. Applicant further describes separating at least a first fraction of the nanoparticles from a mixture of the solvent and the other material (page 5 second paragraph). This is the subject matter of claim 2. The specification then states that the separated nanoparticles can be used in various applications such as forming "a substantially uniform dispersion" of nanoparticles in, for example a polymer (see page 5 second paragraph, and page 7 third and fourth paragraphs).

In the detailed description starting on page 11, Applicant refers to processes which allow for the formation of nanoparticles in a sufficiently non-aggregated state that they can be dispersed relatively evenly into a matrix such as a polymer body. In that state the nanoparticles can be employed to tailor the properties of the matrix in desired ways (page 11 first full paragraph, following the figure description).

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Continuing on page 11, Applicant describes a specific embodiment under the subsection "Synthesis of TiO_2 Nanoparticles". As described therein, a TiO_2 precursor solution is formed from $TiCl_4$ and cyclohexane. Following the evolution of HCl gas there is formed a cloudy suspension of NH_4Cl in the reaction medium, which includes "the TiO_2 nanoparticles" (see page 12).

In the next subsection entitled "Isolation of TiO_2 Nanoparticles", beginning on page 12 and continuing on page 13, the just described reaction medium with TiO_2 nanoparticles is provided and the cyclohexane solvent slowly evaporated to give a cloudy viscous gel containing the TiO_2 (nanoparticles) and NH_4Cl byproduct. To this is added $CHCl_3$, trichloromethane, a common solvent, to precipitate out the NH_4Cl and NaCl which can then be readily separated from the clear supernatant by centrifugation. The $CHCl_3$ supernatant is then concentrated to give a viscous gel which when taken up in methyl alcohol (CH_3OH) gives a crude TiO_2-containing liquor. The process just described is thus one in which a solvent ($CHCl_3$) is added to a mixture of TiO_2 nanoparticles and another material (NH_4Cl byproduct), with the result that the NH_4Cl and NaCl are readily separated from the supernatant by centrifugation and the supernatant is then concentrated to a gel which is taken up in a solvent (methyl alcohol) to give TiO_2 nanoparticles in a solution (liquor). Thus, the skilled person reading the specification, would clearly understand that the TiO_2 nanoparticles continue to exist as particles in the solution, during the above described example of the claimed washing step.

The specification then goes on to describe a further purification of the TiO_2 nanoparticles from excess AOT, in which the crude liquor is placed in cellulose dialysis

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tubing and dialysed against quantities of solvent (methyl alcohol) containing concentrated aqueous HCl. The dialysis, in addition to removing the excess AOT contamination, also improves the size distribution of the particles by removing the smallest particles which could readily pass through the pores of the dialysis tubing. In this way, an optically clear dispersion of TiO_2 nanoparticles in methyl alcohol solution was obtained (page 13 second paragraph). Thus, the skilled person is again clearly taught by the example that the TiO_2 nanoparticles remain as particles in the solution which includes the solvent.

The specification then goes on to describe various applications for the washed nanoparticles beginning at the bottom of page 16. On page 18 there is described the tuning of the refractive index of a polymer film by adding to the film a dispersion of TiO_2 nanoparticles. Four samples of PPV containing varying amounts of TiO_2 are fabricated by blending a volume of precursor PPV-methyl alcohol solution with a TiO_2 nanoparticle-methyl alcohol solution to give the same final concentration of precursor PPV but with different concentrations of TiO_2 particles. The size range of the TiO_2 nanoparticles was approximately 2-8nm (see page 18). Thus, the skilled person is taught that the TiO_2 nanoparticles in solvent solution can be used in various applications, including incorporating them in a polymer to provide a "dispersion of TiO2 nanoparticles" in the polymer.

The above descriptions are consistent with the language of the claims. Claim 1 calls for a method step of washing a mixture of nanoparticles with another material, the method step including washing the mixture with a solvent to remove the other material

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and form a solution of nanoparticles in the solvent. In this "a solution of nanoparticles" the nanoparticles remain as particles, as described in the specification.

The other material may or may not be dissolved. The previously described example is one in which trichloromethane solvent is added and the NH_4Cl (other material) precipitates out and is readily separated by centrifugation. Also in the described embodiment, the TiO_2 is further purified from excess AOT by adding methyl alcohol solvent and using dialysis to remove the excess AOT producing a clear dispersion of TiO_2 nanoparticles in the methyl alcohol solution. In other examples and in the general description of various aspects of the invention on pages 4-6, it is stated that the other material may or may not be soluble in the solvent. In preferred embodiments, the other material is soluble in the solvent or is preferentially soluble to the nanoparticles (see page 6 second paragraph).

Thus, Applicant respectfully asserts that the present claims satisfy the requirement of 35 U.S.C. § 112, second paragraph.

In Applicant's prior submission under 37 C.F.R. § 1.114, filed December 9, 2002, Applicant responded to the prior allegation that "a solution of nanoparticles" was broad enough to encompass a solution of common table sugar or salt dissolved in water. To the extent the Examiner has any further questions in this regard, Applicant refers the Examiner to the arguments in the prior response. In that response, Applicant stated that the common salt and sugar particles to which the prior Examiner refers are not nanoparticles, and points out the inconsistency of the prior Examiner's ignoring the "particle" nature of Applicant's claimed nanoparticles. Applicant also stated that it was obtaining a Declaration on the point regarding common salt and sugar particles.

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Applicant submits herewith a Declaration by the inventor, Peter Ho, who has been active in the field colloid science since 1997. He describes his common understanding of nanoparticles in the filed of colloid science, and distinguishes the claimed "solution of nanoparticles" from a solution of common table sugar or salt dissolved in water. As stated in paragraph 6, when a nanoparticle is in a solution of nanoparticles, the nanoparticle retains the same physical structure as when it is not in such solution. In other words, the nanoparticles are for example merely disaggregated by the solvent. In contrast, when sugar particles dissolve in water, the inter-molecular bonds that are responsible for the particle's crystal structure break down so the sugar is dissolved in the water as free sugar molecules. Thus, after solution, the sugar particle no longer exists in the same form. Further, these dissolved sugar molecules are smaller than the accepted size range of nanoparticles. Therefore the dissolved molecules of sugar or dissolved ions of salt in water do not constitute the claimed nanoparticles.

Thus Applicant respectfully asserts that the present claims 1-35 are in condition for allowance.

Applicant further submits copies of the following five documents, which can be referred to as reciting "solutions" of nanoparticles:

- U.S. Patent Application Publication No. US 2002/0197404 A1, Method Of Activating Non-Conductive Substrate for Use in Electroless Deposition, published December 26, 2002;

- WO 03/008331 A1, Preparation of Carbon Nanotubes, published January 30, 2003;

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- WO 02/087749 A1, Colloid Solution of Metal Nanoparticles, Metal-Polymer Nanocomposites and Methods For Preparation Thereof, published November 7, 2002;

- WO 02/060553 A1, Isolation of Nanoparticles, published August 8, 2002; and

- EP 1039291 A1, Optochemical Sensor and Method for its Construction, published September 27, 2000.

Applicant respectfully requests the reconsideration and reexamination of this application and the timely allowance of the pending claims.

Please grant any extensions of time required to enter this response and charge any additional required fees to our deposit account 06-0916.

Respectfully submitted,

FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER, L.L.P.

Dated: July 11, 2003

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